Journal of Cardiovascular Disease Research

ISSN:0975-3583,0976-2833 VOL14,ISSUE06,2023

Original research article

Ultrasound shear wave elastography evaluation of Breast lesions and correlation with clinical, histopathology.

Authors :

1 **Dr. BHARATH KAKILETI**, Assistant Professor, Department of Radiodiagnosis, KIMS RF.

2 **Dr. Akshay Bhanudas**, Associate Professor, Department of Radiodiagnosis KIMS RF .

3Dr.Sai Likitha Gurram, Assistant Professor, Department of Radiodiagnosis KIMS RF .

4 **Dr. Jaya Venkata Ramya Sathineedi**, Assistant Professor, Department of Surgery, KIMS RF, ,

5 **Dr. kandanala Mallika**, Assistant Professor, Department of Pathology, KIMS RF .

Corresponding Author: Dr. BHARATH KAKILETI, Assistant Professor, Radiodiagnosis, KIMS RF.

Email : bharathnri4u@gmail.com

Phone : 9492316555

ABSTRACT:

INTRODUCTION:

Ultrasound (US) is a useful routine tool in screening and differentiation of different breast masses as benign or malignant. [1, 2]. In recent years, breast ultrasonic shear wave elastography has become new and promising technique obtaining more accurate characterization of breast lesions [4, 5].

The purpose of this study is to

1.Determine the impact of shear-wave elastography (SWE) image quality.

2.Assess diagnostic performance and comparison of shear wave ultrasound elastography to compare with histopathological diagnosis.

This cross-sectional screening and diagnostic study were carried out from December 2020 to August 2022 on patients who attended to the Surgery department with chief complaints of breast mass at KIMS &RF. Before initiation of study Institutional Ethics Committee (IEC) approval in KIMS &RF was taken and also written consent from patients was taken.

Study population included 100 female patients with breast masses who came to surgery department at KIMS RF

Results: Shear wave elastography homogeneity and rates of malignancy according to histopathological examination. In this study SWE homogeneity showing homogenous lesions are 93.8% benign and heterogenous lesions are 94.2 % malignant.

CONCLUSION: Breast SWE is now an adjunct tool in breast ultrasonography to differentiate Breast masses as Benign or Malignant.

KEY WORDS: Shear wave elastography, BIRADS, benign and malignant.

ISSN:0975-3583,0976-2833 VOL14,ISSUE06,2023

INTRODUCTION:

Ultrasound (US) is the best modality in screening and diagnosing of different breast masses as benign or malignant. (1, 2). The Breast Imaging-Reporting and Data System (BIRADS) lexicon of American College of Radiology (ACR) has been widely applied in clinical practice (3). In recent years, breast ultrasonic shear wave elastography has become new and promising technique obtaining more accurate characterization of breast lesions (4, 5). Among the currently used elastography technique, shear wave elastography (SWE) induces shear waves which propagate transversely in to the tissue, and has been confirmed as a quantitative stiffness measurement technique of high reproducibility and less operator dependency, compared to external mechanical compression-based strain elastography (4, 6).

Shear wave elastography is an imaging technique that measures and quantifies the tissue stiffness, and this is obtainable by measuring the speed and assessment of propagation pattern of shear waves in target tissue (7,8,9). Breast carcinoma is the commonest neoplasm among females which represents 31% of feminine tumors, and the second-leading reason behind death among female neoplasm cases. Breast lesions were initially classified into malignant and benign categories (10, 11). Shear wave elastography imaging permits quantification of the breast lesion stiffness in comparison to adjacent tissue (12, 13, 14)

Many studies demonstrated that combination of conventional US with SWE features significantly improved specificity of breast mass assessment without any loss of sensitivity (15–22), and thus could reduce unnecessary biopsies of low-suspicion BI-RADS category 4A masses.

The purpose of this study is to

1. Determine the impact of shear-wave elastography (SWE) image quality parameters on the diagnostic performance of elasticity measurements in classifying breast lesions.
2. Assess diagnostic performance and comparison of shear wave ultrasound elastography for differentiation between benign and malignant breast lesions and also to compare with clinical picture and histopathological diagnosis.

Methods and materials:

This cross-sectional screening and diagnostic study were carried out from December 2020 to August 2022 on patients who came with chief complaints of breast mass to the Department of General surgery at Konaseema Institute of Medical Sciences and Research Foundation (KIMS &RF). Before initiation of study Institutional Ethics Committee (IEC) approval in KIMS &RF was taken and also written consent from patients was taken.

Study Population: Study population include 100 female patients with breast masses who came to surgery department at Konaseema Institute of Medical Sciences and Research Foundation.

Inclusion Criteria: Patients with breast discomfort, discharge and mass and women with family history of Breast carcinoma.

Exclusion Criteria: (a) patients with anechoic cystic lesions on conventional breast ultrasound, (b) breast implants, (c) cutaneous lesions, (d) superficial lesions (< 5 mm deep to the skin surface), (e) patients refused to participate in the study.

All patients were subjected to revision of their medical history, clinical breast examination, conventional B mode breast ultrasonography scan with categorization of masses according to BIRADS categories, and shear wave ultrasound elastography. Histopathological assessments for all masses were done. Comparison of conventional US and US elastography results with histopathological results was done

ISSN:0975-3583,0976-2833 VOL14,ISSUE06,2023

All patients were subjected to conventional B-mode ultrasonography, strain, and shear wave elastography by using Logic P9 (GE Healthcare Medical System, USA) with high frequency linear transducer L3-12 (12 MHz).

Conventional B-mode US imaging of both breasts was performed with radial scanning of the whole breast tissue and axillary tail. Longitudinal and transverse images of breast lesions were obtained. Assessment of detected breast lesions for location, size, shape, borders, margin, orientation, echogenicity, posterior acoustic shadowing, presence of calcifications foci, and surrounding tissue was done. Lesions were classified according to BI-RADS for conventional breast sonography as the following: category 1 referred to negative results, category 2 lesions referred to benign lesions, category 3 as probably benign, category 4 (a, b and c) as suspicious for being malignant, category 5 as most probably of malignancy, category 6 lesions were pathologically proven to be malignant.

Shear wave elastography technique: Elastography images of the shear wave were obtained without any transducer pressure (9, 23). A Region of interest (ROI) rectangular box was adjusted on the observed target lesion including sufficient amount of surrounding healthy breast tissue. After a few seconds of no motion to permit stabilization of the shear wave image, freeze shear wave elastography once an ideal image has been obtained. Quantitative elasticity values were ranged from 0 to 180 kPa and displayed as a color scale ranged from dark blue (lowest stiffness) to red (highest stiffness). The investigator placed automated fixed sized ROIs over the hard or stiff portion of the lesion involving the nearby stiff tissue halo, six additional ROIs were placed at the target lesion at different planes. Another ROIs of similar size were placed in subcutaneous fat. Measurement of mean elasticity value and stiff ratio were automatically calculated.

Histopathological Examination: Histopathological diagnosis of all examined breast lesions were performed by pathologists. Samples were taken by fine needle aspiration cytology (FNAC), core biopsy, surgical excision, or radical surgery.

Histopathological data as reference gold standard for diagnosis, comparison with ultrasound elastography values were done.

Statistical analysis: The data was calculated and arranged into different comparison tables and statistical analysis was done by using Statistical Package for Social Sciences software (SPSS), 21st version.

Results:

Total 100 cases were noted and among them 3 cases are between 20 to 30 years age group, 20 cases between 31 to 40 years age group and 43 cases are between 41 to 50 years age group, 26 cases between 51 to 60 years age group and 8 cases are between 61 to 75 years age group as shown in table 1.

As per the histopathological report given by pathologist the total number of benign cases are 63 and 37 cases are malignant out of 100 cases.

Cases according to the age group are shown in table 2.

As per the BIRADS score the distribution of benign and malignant breast lesions are given as below which are compared with the histopathological examination study. Here in this study BIRADS 1 and 2 score lesions are exactly 100% Benign and BIRADS 5 and 6 score lesions are 100% malignant according to histopathological examination. BIRADS score 4 which is suspicious for malignancy showed 25% benign and 75% showed malignant HPE report and the cases details are shown in table 3.

Shear wave elastography homogeneity and rates of malignancy according to histopathological examination. In this study SWE homogeneity showing homogenous lesions are 93.8% benign and heterogenous lesions are 94.2 % malignant and the cases are shown in table 4.

ISSN:0975-3583,0976-2833 VOL14,ISSUE06,2023

Shear wave elastography shapes and rates of malignancy according to histopathological examination are differentiated as oval, round and irregular shapes. Among them all the irregular breast masses are 100% malignant 97.2% oval breast masses are benign and 93.1% round breast masses are benign and all the cases are shown in table 5.

Shear wave elastography color and rates of malignancy according to histopathological examination. All the blue shaded lesions are benign and exactly 100% matching with HPE. All the orange and red shaded lesions are malignant 100% as in fig 2 and 3. And green shaded lesions are 92.8% benign and 7.1% malignant (fig 1) as shown in table 6.

Discussion:

In this study total 100 cases were noted and among them 3% cases are between 20 to 30 years age group, 20% cases between 31 to 40 years age group and 43% cases are between 41 to 50 years age group, 26% cases between 51 to 60 years age group and 8 % cases are between 61 to 75 years age group.

In Chavan SG et al study (24) 20.6% cases are malignant between the age group of 35 to 45 years age and 32.4% cases are malignant between 56 to 65 years age group. Here the age wise malignant cases are almost equal between 30 to 45 years age group for the two studies.

In Mohan et al study (25) the greater number of malignant cases are seen between the age group of 51 to 60yrs i.e., 40% but in this present study 43% cases are between 41 to 50 years age.

In the study conducted by Arsalan et al (26) majority of malignant lesions are at 41 to 50 years age group which is coinciding with this present study.

In this study among the total 100 cases 63% are benign cases and 37 % are malignant cases.

In Chavan SG et al study (24) 34% are malignant and 66% are benign which are almost nearby.

In study conducted by Navya et al (27) they found that 64% cases were benign and 36 cases were malignant.

So, this present study is almost coinciding with Chavan SG et al (24) and Navya et al (27)

But there are some similar studies where there is variation between benign and malignant ratio.

In Soyder (28) et al study 75% cases are benign and 25% cases are malignant.

In Kaira et al (29) study 41% cases are benign and 59% cases are malignant which is showing contrary to the present study.

In the present study the cases which are under BIRADS score 1 are 21%. Under BIRADS score 2 are 14%, under BIRADS score 3 are 18% under BIRADS score 4 are 15%, under BIRADS score 5 are 8% and under BIRADS score 6 are 24%. BIRADS 1 and 2 score lesions are exactly benign 100% according to histopathological examination and BIRADS 5 and 6 score lesions are 100% malignant according to histopathological examination. BIRADS score 4 which is suspicious for malignancy showed 25% benign and 75% showed malignant HPE report.

In Shinn-Huey S Chou et al (30) study of comparison of BIRADS and histopathological study benign lesions are under BIRADS 2 and 3 whereas malignant cases are under BIRADS 5 and 6 which is almost similar to our study.

In Ya -ling Chen et al (31) study of comparison of BIRADS and HPE showed all benign under BIRADS 1,2 and 3. Suspicious cases under BIRADS 4 and malignant cases under BIRADS 5 and 6 which is corelating to our study.

In the present study comparison of Shear wave elastography homogeneity and rates of malignancy according to histopathological examination, homogenous lesions are 93.8% benign and heterogenous lesions are 94.2 % malignant the Sensitivity was 96.83% and Specificity was 89.19% and the Positive Predictive Value (PPV) was 93.85% and Negative Predictive Value (NPV) was 94.29%.

In S.Hari et al (32)study of 119 breast mass cases the shear wave elastography results compared with the gold standard HPE showed 93.5 sensitivity and 82.5 specificity and the PPV and NPV are 85.3 and 92.2 respectively which is almost near to the present study.

In Xi Lin et al (33) study in comparison of shear wave elastography with homogeneity of breast masses their study showed sensitivity as 91.5 and specificity as 86.4 and the PPV and NPV are 76.9 and 95.3 respectively which is corelating to the present study.

In Shui luo et al (34) study with similar comparison sensitivity and specificity are 95 and 95.1 respectively and PPV and NPV are 95 and 95.1 respectively which are almost near to the values of the present study.

In Hui yang et al (35) study with similar comparison sensitivity and specificity are 66.7 and 70 respectively and PPV and NPV are 71.0 and 65.6 respectively which are showing slight differences.

The Shear wave elastography study showing the comparison of the SWE shapes and SWE colors are also corelating with studies of S.Hari et al (32), Xi Lin et al (33), Shui luo et al (34) and Hui Yang et al (35) studies.

CONCLUSION:

Shear wave elastography is an advanced technique uses shear waves to assess elasticity of the tissues. Breast Shear wave elastography is now an adjunct tool in breast ultrasonography to differentiate Breast masses as Benign or Malignant. It is easily done, Noninvasive, takes less time and therefore patient acceptancy rate is high in clinical practice. One of the best applications of SWE is the characterization of BI-RADS category 3 and 4a Breast masses and to reduce unnecessary breast biopsies. However, the possibility of false-positive and false-negative results should be considered during interpretation. In clinical practice, we should fully understand the ultrasound image features and pathological characteristics of different breast masses and elastography parameters to make a comprehensive analysis and accurate diagnosis.

References:

1.Berg WA, Bandos AI, Mendelson EB, Lehrer D, Jong RA, Pisano ED. Ultrasound as the Primary Screening Test for Breast Cancer: Analysis From ACRIN 6666. J Natl Cancer Inst. 2015;108(4) https://doi.org/10. 1093/jnci/djv367.

2. Taylor KJ, Merritt C, Piccoli C, Schmidt R, Rouse G, Fornage B, et al. Ultrasound as a complement to mammography and breast examination to characterize breast masses. Ultrasound Med Biol. 2002;28(1):19–26.

3. Mendelson EB, Böhm-Vélez M, Berg WA, et al. ACR BI-RADS® ultrasound. In: ACR BI-RADS® atlas, breast imaging reporting and data system. Reston, VA. American college of Radiology. 2013. (see: https://www.acr.org/ClinicalResources/Reporting-and-Data-Systems/Bi-Rads/Permissions).

4. Gennisson JL, Deffieux T, Fink M, Tanter M. Ultrasound elastography: principles and techniques. Diagn Interv Imaging. 2013;94(5):487–95. https:// doi.org/10.1016/j.diii.2013.01.022.

5. Ng WL, Rahmat K, Fadzli F, Rozalli FI, Mohd-Shah MN, Chandran PA, et al.

Shearwave Elastography increases diagnostic accuracy in characterization of breast lesions. Medicine (Baltimore). 2016;95(12):e3146. https://doi.org/10.1097/MD.0000000000003146.

6. Cosgrove DO, Berg WA, Dore CJ, Skyba DM, Henry JP, Gay J, et al. BE1Study Group. Shear wave elastography for breast masses is highlyreproducible. Eur Radiol. 2012;22(5):1023–32. https://doi.org/10.1007/s00330-011-2340-y.

7.Goenezen S, Dord JF, Sink Z et al (2012) Linear and nonlinear elasticmodulus imaging: an application to breast cancer diagnosis. IEEE Trans MedImaging 31:1628–1637

8. Athanasiou A, Tardivon A, Tanter M et al (2010) Breast lesions: quantitativeelastography with supersonic shear imaging-preliminary results. Radiology256:297–303

9. Jung MC, Jae-Kyung W, Kyoung-Bunn L et al (2013) Comparison of shearwave and strain ultrasound elastography in the differentiation of benignand malignant breast lesions. AJR 201:W347–W356

10.Catalano O, Nunziata A, Siani A (2009) The breast, in Fundamentals inOncologic Ultrasound. Sonographic Imaging and Intervention, 7th edn.Springer Verlag Italia, pp 145–179

11. Itoh A, Ueno E, Tohno E et al (2006) Breast disease: clinical application of USelastography for diagnosis. Radiology 239:341–350.

12.Barr RG, Kazutaka N, Dominique A et al (2015) WFUMB Guidelines forUltrasound Elastography Breast. Ultrasound Med Biol 41(5):1148–1160

13. Barr RG, Destounis S, Lackey LB II et al (2012) Evaluation of breast lesionsusing sonographic elasticity imaging: a multicenter trial. J Ultrasound Med31:281–287

14. Barr RG (2015) Breast elastography, 1st edn. Thieme Medical Publishers,Stuttgart

15.Barr RG. Sonographic breast elastography: a primer. J Ultrasound Med 2012;31:773-783.

16. Youk JH, Son EJ, Gweon HM, Kim H, Park YJ, Kim JA. Comparison of strain and shear wave elastography for the differentiation of benign from malignant breast lesions, combined with B-mode ultrasonography: qualitative and quantitative assessments.

17.Ultrasound Med Biol 2014;40:2336-2344. Tan SM, Teh HS, Mancer JF et al (2008) Improving B mode ultrasound evaluation of breast lesions with real time ultrasound elastography, A clinical approach. Breast 17(3):252–257

18.Berg WA, Cosgrove DO, Doré CJ, Schäfer FK, Svensson WE, Hooley RJ, et al.BE1 investigators. Shear-wave elastography improves the specificity of breast US: the BE1 multinational study of 939 masses. Radiology. 2012;

262(2):435–49. https://doi.org/10.1148/radiol.11110640.

19. Gweon HM, Youk JH, Son EJ, Kim JA. Clinical application of qualitative assessment for breast masses in shear-wave elastography. Eur J Radiol. 2013; 82(11):e680–5. https://doi.org/10.1016/j.ejrad.2013.08.004.

20. Lee SH, Chang JM, Kim WH, Bae MS, Seo M, Koo HR, et al. Added value of shearwave elastography for evaluation of breast masses detected with screening US imaging. Radiology. 2014;273(1):61–9. https://doi.org/10.1148/radiol.14132443.

21. Klotz T, Boussion V, Kwiatkowski F, Dieu-de Fraissinette V, Bailly-Glatre A, Lemery S, et al. Shear wave elastography contribution in ultrasound diagnosis management of breast lesions. Diagn Interv Imaging. 2014;95(9):

813–24. https://doi.org/10.1016/j.diii.2014.04.015.

22. Giannotti E, Vinnicombe S, Thomson K, McLean D, Purdie C, Jordan L, Evans A. Shear-wave elastography and grayscale assessment of palpable probably benign masses: is biopsy always required? Br J Radiol. 2016;89(1062):

20150865. https://doi.org/10.1259/bjr.20150865

ISSN:0975-3583,0976-2833 VOL14,ISSUE06,2023

23.Mirinae S, Hye SA, Sung HP et al (2017) Comparison and combination of strain and shear wave elastography of breast masses for differentiation ofbenign and malignant lesions by quantitative assessment-preliminary study.J Ultrasound Med. https://doi.org/10.1002/jum.14309

24. Chavan SG, Ganesh BS, Vemuri N. Diagnosis of breast lumps based on Breast Imaging Reporting and Data System score and histopathological examination: a comparative study. Int Surg J 2020;7:144-9

25.Mohan A, Kumar C. Clinical profile and management of breast cancer in women in a rural based tertiary care hospital our experience. Intern Surg J. 2017;4(2):697-702

26.Arsalan FA, Subhan AN, Rasul SH, Jalali UZ, Yousuf M, Mehmood Z. Sensitivity and specificity of BI-RADS scoring system in carcinoma of breast. J Surg Pak. 2010;15(1):38-43

27. Navya BN, Thomas S, Hiremath R, Alva SR. Comparison of Diagnostic Accuracy Of BIRADS Score With Pathologic Findings In Breast Lumps. Annals Pathol Lab Med. 2017;4(3):A236-42

28. Soyder A, Taşkın F, Ozbas S. Imaging-histological discordance after sonographically guided percutaneous breast core biopsy. Breast care. 2015;10(1):33-7

29. Kaira V, Aggarwal A, Kaira P. Clinical profile of breast lesions - a hospital based study. International J Contemp Med Res. 2017;4(6):1294-6

30. Chou SS, Baikpour M, Zhang W, Mercaldo SF, Lehman CD, Samir AE. Shear-Wave Elastography of the Breast: Impact of Technical Image Quality Parameters on Diagnostic Accuracy. AJR Am J Roentgenol. 2021 May;216(5):1205-1215. doi: 10.2214/AJR.19.22728. Epub 2021 Mar 17. PMID: 33729888.

31. Chen YL, Gao Y, Chang C, Wang F, Zeng W, Chen JJ. Ultrasound shear wave elastography of breast lesions: correlation of anisotropy with clinical and histopathological findings. Cancer Imaging. 2018 Apr 5;18(1):11. doi: 10.1186/s40644-018-0144-x. PMID: 29622044; PMCID: PMC5887177.

32. Hari S, Paul SB, Vidyasagar R, Dhamija E, Adarsh AD, Thulkar S, Mathur S, Sreenivas V, Sharma S, Srivastava A, Seenu V, Prashad R. Breast mass characterization using shear wave elastography and ultrasound. Diagn Interv Imaging. 2018 Nov;99(11):699-707. doi: 10.1016/j.diii.2018.06.002. Epub 2018 Jul 10. PMID: 30006125.

33. Lin X, Chang C, Wu C, Chen Q, Peng Y, Luo B, Tang L, Li J, Zheng J, Zhou R, Cui G, Li A, Wang X, Qian L, Zhang J, Wen C, Gay J, Zhang H, Li A, Chen Y. Confirmed value of shear wave elastography for ultrasound characterization of breast masses using a conservative approach in Chinese women: a large-size prospective multicenter trial. Cancer Manag Res. 2018 Oct 11;10:4447-4458. doi: 10.2147/CMAR.S174690. PMID: 30349377; PMCID: PMC6187919.

34. shuyi luo Front. Oncol., 02 July 2019 Sec. Cancer Imaging and Image-directed Interventions Volume 9 - 2019 | https://doi.org/10.3389/fonc.2019.00533 Qualitative Classification of Shear Wave Elastography for Differential Diagnosis Between Benign and Metastatic Axillary Lymph Nodes in Breast Cancer

Table 1

Age group	No.of cases	Percentage
20 to 30 years	3	3%
31 to 40 years	20	20%
41 to 50 years	43	43%
51 to 60 years	26	26%
61 to 75 years	8	8%

ISSN:0975-3583,0976-2833 VOL14,ISSUE06,2023

Table 2:

Age group	Benign	Malignant
20 to 30 years	3	0
31 to 40 years	14	6
41 to 50 years	23	20
51 to 60 years	17	9
61 to 75 years	6	2
Total	63 (63%)	37 (37%)

* Chi-square=4.41; P-value=0.354; Not Significant.

Table 3:

BIRADS SCORE	Total no of cases	HPE positive	HPE negative
1	21	0	21 (100%)
2	14	0	14(100%)
3	18	2 (11.1%)	16(88.8%)
4	15	3 (25%)	12 (75%)
5	8	8 (100%)	0
6	24	24 (100%)	0
Total	100	37 %(Malignant)	63 % (Benign)

* Chi-square=82.08; P-value=0.000; Highly Significant.

Table 4:

SWE Homogeneity	Benign	Malignant	Total
Homogenous	61 (93.8%)	4 (6.15%)	65
Heterogenous	2 (6%)	33 (94.2%)	35
Total	63	37	100

* Sensitivity=96.83%; Specificity=89.19%;

**Positive Predictive Value=93.85%; Negative Predictive Value=94.29%.

* Chi-square=75.8063; P-value< 0.0001; which is highly Significant.

Table 5:

SWE Shapes	Benign	Malignant	Total
Oval	36 (97.2%)	1 (2.7%)	37
Round	27 (93.1%)	2 (6.8%)	29
Irregular	0	34 (100%)	34
	63	37	100

* Chi-square=87.84; P-value=0.000; Highly Significant.

ISSN:0975-3583,0976-2833 VOL14,ISSUE06,2023

Table 6:

SWE Color	Benign	Malignant	Total
Dark blue (0- 36 kPa)	27 (100%)	0	27 (Benign)
Light blue (36-72 kPa)	22(100%)	0	22 (Benign)
Green (72-108 kPa)	13 (92.8%)	1 (7.1%)	14 (Benign to Malignant)
Orange (108-144 kPa)	1 (16.6%)	5 (83.3%)	6 (Malignant)
Red (144 – 180 kPa)	0	31 (100%)	31 (Malignant)
Total	63	37	100

* Chi-square=92.44; P-value=0.000; Highly Significant.